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HARTCROWSER

Earth and Environmental Technologies

Dredge Material Characterization
Hurlen Construction Company and Boyer Alaska Barge Lines
Berthing Areas
Duwamish Waterway
Seattle, Washington

Prepared for
Hurlen Construction Company
and Boyer Alaska Barge Lines

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HURLEN CONSTRUCTION COMPANY
AND BOYER ALASKA BARGE LINES
BERTHING AREAS
DUWAMISH WATERWAY
SEATTLE, WASHINGTON

1.0 INTRODUCTION

This report presents the results of the Puget Sound Dredged Disposal Analysis (PSDDA) sediment characterization performed at the Hurlen Construction Company (Hurlen) and Boyer Alaska Barge Lines (Boyer) berthing areas located in the Duwamish Waterway, Seattle, Washington. The purpose of this study is to characterize dredge prism sediments in support of the permitting process for maintenance dredging of the Hurlen and Boyer berthing areas. To meet this objective, two core samples of the proposed dredge prism and underlying materials were collected from each of the four Dredge Material Management Units (DMMUs C1, C2, C3, and C4) identified at the Hurlen site and from each of two DMMUs (C5 and C6) identified at the Boyer site. Six composite samples, representative of the material in each DMMU were analyzed for Dredge Material Management Program (DMMP)-specified chemical, conventional, and grain size parameters. Four of the composite samples, representative of DMMUs C1, C4, C5, and C6 were also subjected to biological toxicity testing.

The results of this sediment characterization show that concentrations of select PSDDA chemicals of concern are above screening levels in the representative samples; however, biological testing results indicate that the proposed dredge materials represented by DMMUs C1, C4, C5, and C6 do not exhibit toxicity effects relative to PSDDA non-dispersive open water disposal criteria. Therefore, sediments within DMMUs C1, C4, C5, and C6 meet suitability criteria for disposal at the Elliott Bay PSDDA unconfined open water disposal site. Sediments contained within DMMUs C2 and C3 do not meet these requirements.

The Sampling and Analysis Plan for this project was prepared in accordance with, and approved by, the US Army Corps Dredged Material Management Office (Corps, 1998). Sediment sampling, handling, and analysis were conducted in general accordance with the protocols established by the DMMP (1998), Puget Sound Estuary Program (1989, 1989a, and 1989b), and Environmental Protection Agency (1983a, 1983b, 1986, 1991a, 1991b, and 1991c), as specified in the Project Plan and subsequent memoranda by Hart Crowser (Hart Crowser, 1998a and 1998b).

1.1 Background

Hurlen Construction and Boyer Alaska Barge Lines propose to perform maintenance dredging at their berthing facilities located in the 1st Avenue to 8th Avenue reach of the Duwamish Waterway. The location of the project sites are shown on Figure 1. Corps permit reference numbers for the Hurlen and Boyer project are 98-2-00476 and 98-2-00477, respectively.

Maintenance dredging of the Hurlen Site (Figure 2) will be performed to remove approximately 15,100 cubic yards (cy) of sand and silt from the pier face and adjacent areas to restore the draft depth to its previously authorized elevation of -10 feet Mean Lower Low Water (MLLW). Deepening of this berthing area is necessary to maintain barge access to the berthing facility. Presently, conditions at the site cause grounding of vessels during low tide conditions and thus constitute a navigational hazard.

Maintenance dredging of the Boyer Site (Figure 3) will be performed to remove approximately 8,000 cy of materials from the pier face and adjacent off-loading berth to restore the draft depth to an elevation of -10 feet MLLW. Berthing areas at the Boyer site are currently authorized to an elevation of -8 feet MLLW. The permit applicant proposes to deepen the existing berth to a uniform elevation of -10 feet MLLW to accommodate ocean-going tugs and barges year round. The additional berth deepening will reduce the need for frequent future maintenance dredging. Presently, conditions at the site cause grounding of vessels during low tide conditions and thus constitute a navigational hazard.

The preferred proposed disposal alternative for both projects is transfer to and discharge of the dredged material at the PSDDA-designated non-dispersive, Elliott Bay unconfined open water disposal site located near the terminus of the Duwamish Waterway.

2.0 SEDIMENT SAMPLING

2.1 Sample and Survey Location Control

Sediment sampling locations for this study were selected to provide adequate spatial coverage of the proposed dredge prism material located within each DMMU. The sampling locations are believed to be representative of the sediment conditions of the dredge prism. Sediment cores representing the depth of the dredge prism were collected at eighteen locations as shown on Figures 2 and 3.

Sediment coring was accomplished using Hart Core Sampler methods. Sample collection was performed by Hart Crowser personnel working from the vessel *Shelly Marie* subcontracted from Kushner Marine Services of Anacortes, Washington. Samples were obtained on August 27 and 28, 1998. A summary of field sampling results is presented in Table 1.

The sampling locations were surveyed using a Differential Global Positioning System with ± 3 meters accuracy. Location coordinates for several sampling locations were not obtained as site blockages (such as by barges) prevented sampling vessel access. In these cases, the sampler was deployed by hand from the blocking barge and the location was hand-surveyed. Latitude and longitude coordinates for the sampling locations are presented in Table 1. Confirmed sampling locations are shown on Figures 2 and 3.

2.2 Sediment Sampling, Handling, and Analysis

Upon retrieval of the core samples, the acceptability of each core was assessed relative to the criteria established in the Project Plan (Hart Crowser, 1998a). After acceptance, the core samples were logged and subsampled in the field. The composite samples were processed upon collection of the two core sections contributing to each composite.

Processing of the sediment core samples consisted of opening the core sampler longitudinally and removing material representing the desired sample compaction-corrected interval. After removal, material from each interval was placed into a designated stainless steel bowl for homogenization. Composite samples were created by homogenizing equal proportions of sediment from the respective core locations included in each composite. The sample compositing scheme used in this characterization study is presented in Table 2.

Once sediments for a given composite sample were retrieved, the sediment was well-homogenized prior to transfer to a specific sample container. After filling, sample containers were placed in a cooled ice chest for transport to the analytical laboratory under chain of custody procedures. Samples were transported to the laboratory under the chain of custody procedures described in the Sampling and Analysis Plan. Composite samples were analyzed for the PSDDA chemicals of concern and conventionals including: metals, tributyltin, organics, chlorinated hydrocarbons, phthalates, phenols, volatile organics, pesticides, polychlorinated biphenyls (PCBs), other miscellaneous extractables, and grain size. Sediment chemical analysis was performed by Columbia Analytical Services. Grain size analysis was performed by Hart Crowser. Composite samples representative of the material underlying proposed dredge

material were collected and archived at the analytical laboratory, consistent with the PSDDA-approved Project Plan.

Subsamples submitted for analysis of volatile and sulfide compounds were collected directly from the sediment core sample prior to homogenization. Subsamples submitted for pore water tributyltin analysis were collected from each of the representative composite samples. Multiple deployments were performed to ensure collection of adequate sediment volume. Pore water extraction was performed on all of the samples submitted. However, tributyltin analysis was performed on only one sample from each site (C2 and C5) in accordance with the Project Plan. Subsequent pore water tributyltin analysis was not performed as the initial results indicated concentrations were below detection limits.

As a result of laboratory error, volatiles analysis was not performed on the composite samples within the required holding times. In an effort to avoid additional field sampling, biological testing was performed on select samples. Biological testing was performed only on samples with marginal PSDDA Screening Level (SL) exceedences (C1, C4, C5, and C6). Communication with the Dredged Material Management Office confirmed that the biological testing results could be used in lieu of the sediment volatiles data since historical data for at each site did not indicate a concern for elevated volatiles concentrations (Sterling, 1998). Biological testing was performed by Parametrix, Inc. as reported in Appendix B.

3.0 SEDIMENT PHYSICAL CHARACTERISTICS

Descriptions of the sediment cores were recorded during processing. Discrete core sample descriptions are presented in Table 3.

Grain size distribution was determined for each composite sample following PSEP protocols. After analysis, the sample was classified in accordance with the Unified Soil Classification (USC) System. A summary of grain size characterization results is presented in Table 4.

4.0 SEDIMENT CHEMICAL ANALYSIS RESULTS

4.1 Data Validation

Overall, the Data Quality Objectives (DQOs), as set forth in the Project Plan (Hart Crowser, 1998a), were met, and the data for this project are acceptable for use as reported. With the exception that volatiles analysis were omitted, the

data for this project are 100 percent complete. No results were rejected as the result of the QA/QC review.

A detailed chemical data quality review and laboratory certificates of analysis are presented in Appendix A. Results of the sediment chemical analysis, compared to PSDDA sediment chemical guidelines are presented in Tables 5 and 6.

4.2 Metals

The ten metals analyzed for were detected in the four Hurlen site composite sediment samples analyzed. Concentrations of these detected constituents did not exceed the PSDDA SL.

The ten metals analyzed for were detected in the two Boyer site composite sediment samples analyzed. Concentrations of these detected constituents did not exceed the PSDDA SL.

4.3 Tributyltin

Tributyltin was not detected in the two composite sediment samples analyzed.

4.4 Pesticide/PCB

Pesticide constituents were not detected in the four Hurlen site samples analyzed; however, detection limits for total DDT were above the SL in samples C2 and C3. Detected total PCB concentrations were below the SL in the four Hurlen site sediment samples.

Pesticide compounds were not detected in the Boyer site samples analyzed. Total PCBs were detected above the SL in sample C6.

4.5 Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LPAHs)

The seven LPAH compounds analyzed for were detected in the Hurlen site composite samples. Concentrations of acenepthene, fluorene, and phenenthrene exceed the SL in at least one sample. Total LPAHs exceeded the SL in the four samples analyzed. Acenepthene was detected above the PSDDA Maximum Level (ML) in sample C3.

Five of the seven LPAH compounds analyzed for were detected in both of the Boyer site samples. Concentrations of the detected constituents did not exceed the SL.

4.6 High Molecular Weight Polycyclic Aromatic Hydrocarbons (HPAHs)

The ten HPAH compounds analyzed for were detected in the Hurlen site composite samples. Concentrations of benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, ideno(1,2,3-cd)pyrene, and pyrene exceeded the SL in at least one sample. Total benzofluoranthenes exceeded the SL in sample C3 and total HPAHs exceeded the SL in samples C2 and C3.

The ten HPAH compounds analyzed for were detected in at least one of the Boyer site samples. Concentration of the detected constituents did not exceed the SL.

4.7 Phenol

Three of the five phenol constituents analyzed for were detected in at least one of the Hurlen site samples. Concentrations of these detected constituents did not exceed the PSDDA SL.

Phenols were not detected in the Boyer site samples.

4.7 Phthalate

Two of the six phthalate compounds analyzed for were detected in at least one of the Hurlen site samples. Concentrations of these detected constituents did not exceed the PSDDA SL.

Two of the six phthalate compounds analyzed for were detected in at least one of the Boyer site samples. Concentrations of these detected constituents did not exceed the PSDDA SL.

4.8 Semivolatile Compounds

One of the eight semivolatile constituents analyzed for was detected in the Hurlen site samples. The concentrations of this detected constituent did not exceed the SL.

One of the eight semivolatile constituents analyzed was detected in the Boyer site samples. The concentrations of this detected constituent did not exceed the SL.

5.0 SEDIMENT BIOLOGICAL TOXICITY TESTING RESULTS

5.1 Data Validation

Overall, the Data Quality Objectives (DQOs), as set forth in the Project Plan (Hart Crowser, 1998a), were met, and the data for this project are acceptable for use as reported. With the exception explained below, the data for this project are 100 percent complete. No results were rejected as the result of this QA/QC review.

Initial bivalve species testing results failed to meet PSDDA control criteria. Subsequent testing was not performed as adequate test species were not available within the holding time period. Communications between the testing laboratory and the DMMO (see Appendix B) on this issue resulted in the resolution that results of the amphipod and juvenile infaunal growth tests will be adequate for a PSDDA open water suitability determination.

A detailed data quality review and the Parametrix Biological testing results report are presented in Appendix B. A summary of biological testing results compared to PSDDA sediment chemical guidelines are presented in Tables 7 and 8.

5.2 10-Day Amphipod Acute Mortality Test

Amphipod bioassay testing was performed on two Hurlen site samples (C1 and C3), two Boyer site samples (C5 and C6), two reference sediments, and one clean, negative control sediment using *Ampelisca abdita*. The results of these bioassays were interpreted relative to the PSDDA Tier III Bioassay Interpretive Criteria for non-dispersive sites and are summarized in Table 7. One test sediments (C6) had results that were statistically different from reference sediment response, but the magnitude of the difference was not sufficient to result in a failure. The four test sediments were determined to pass PSDDA open water disposal suitability criteria.

5.3 20-Day Juvenile Infaunal Growth Test

Juvenile infaunal growth testing was performed on two Hurlen site samples (C1 and C3), two Boyer site samples (C5 and C6), two reference sediments, and one clean, negative control sediment using *Neanthes arenaceodentata*. The results of these bioassays were interpreted relative to the PSDDA Tier III Bioassay Interpretive Criteria for non-dispersive sites and are summarized in Table 8. One test sediments (C5) had results that were statistically different from reference sediment response, but the magnitude of the difference was not sufficient to

result in a failure. The four test sediments were determined to pass PSDDA open water disposal suitability criteria.

6.0 LIMITATIONS

Work for this project was performed, and this report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Hurlen Construction Company and Boyer Alaska Barge Lines for specific application to the referenced property. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

Any questions regarding our work and this report, the presentation of the information, and the interpretation of the data are welcome and should be referred to the undersigned.

We trust that this report meets your needs.

HART CROWSER, INC.

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Table 1 - Summary of Field Sampling Results

Sample Location	North Latitude	West Longitude	Mudline Elevation in Feet MLLW	Core Penetration in Feet	Sample Recovery in Feet	Estimated Core Compaction in Percent	Core Penetration Elevation in Feet MLLW	Notes
DMMU C1								
H1	47° 32.061'	122° 19.725'	-5.0	3.1	3.0	3.2	-8.1	Due to limited penetration resulting from consolidated subsurface material, full dredge depth sample was not achieved and no archive sample was collected. Two deployments were attempted.
H2	ND	ND	-7.5	4.4	3.9	11.4	-11.8	
DMMU C2								
H3	47° 32.062'	122° 19.432'	-7.5	4.4	4.0	9.1	-11.9	
H4	ND	ND	-7.0	4.0	3.7	7.5	-11.0	
DMMU C3								
H5	47° 32.111'	122° 19.509'	-8.0	3.3	3.0	9.1	-11.3	
H6	ND	ND	-8.0	3.3	3.0	9.1	-11.3	
DMMU C4								
H7	47° 32.128'	122° 19.546'	-8.5	2.6	2.5	3.8	-11.1	Barge blocked proposed location. Two deployments were attempted.
H8	47° 32.107'	122° 19.506'	-7.0	4.0	3.5	12.5	-10.9	
DMMU C5								
B1	47° 32.258'	122° 19.751'	-7.7	2.3	2.0	13.0	-10.0	Three deployments were required to achieve sufficient sample volume. Archive collected from third deployment.
B2	47° 32.253'	122° 19.730'	-7.7	4.4	4.0	9.1	-12.1	
DMMU C6								
B3	47° 32.239'	122° 19.706'	-7.5	4.4	4.0	9.1	-11.9	
B4	47° 32.253'	122° 19.730'	-7.0	3.2	2.9	9.4	-10.2	

Notes:
ND - No data obtained. Field conditions obstructed DGPS.

Table 2 - Sample Compositing Scheme

Sample Identification	Core Samples
Hurlen Site	
C1	H1, H2
Z1	H2
C2	H3, H4
Z2	H3, H4
C2	H5, H6
Z3	H5, H6
C4	H7, H8
Z4	H7, H8
Boyer Site	
C5	B1, B2
Z5	B1, B2
C6	B3, B4
Z6	B3, B4

4902/BerthingAreas.xls - table 2

Table 3 - Discrete Core Sample Description

Core Sample Identification	Sample Depth Interval in Feet	Visual Sediment Description
Hurlen Site		
H1	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 1.0	Medium stiff, black SILT
	1.0 to 3.0	Black, medium to fine SAND with black Silt interbedding
H2	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 3.9	Dark gray to black, clayey SILT with occasional wood fragments
H3	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 4.0	Dark gray to black, clayey SILT with occasional wood fragments and oil sheen
H4	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 4.0	Dark gray to black, clayey SILT with occasional wood fragments and oil sheen
H5	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 3.3	Dark gray to black, clayey SILT with occasional wood fragments
H6	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 3.3	Dark gray to black, clayey SILT with occasional wood fragments
H7	0.0 to 0.5	Soft, green, gray, clayey SILT and oil sheen
	0.5 to 1.0	Dark gray SILT
	1.0 to 2.6	Dark gray to black, clayey SILT with occasional wood fragments
H8	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 1.0	Slightly to very sandy SILT
	1.0 to 2.4	Black, coarse SAND with Silt interbedding and occasional wood fragments
	2.4 to 3.5	Brown SILT with black sand lenses
Boyer Site		
B1	0.0 to 0.5	Brown, slightly sandy SILT
	0.5 to 1.8	Dense, brown, medium to fine SAND with Silt interbedding and occasional gravel
	1.8 to 2.0	Black SILT
B2	0.0 to 0.6	Brown, medium stiff, slightly sandy SILT
	0.6 to 0.8	Medium to fine SAND
	0.8 to 1.5	Black, slightly sandy SILT with Sand interbedding
	1.5 to 2.5	Black, silty SAND
	2.5 to 4.0	Black, medium to fine SAND with Silt interbedding
B3	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 3.3	Black SILT with Sand interbedding
	3.3 to 4.0	Brown, medium to fine SAND
B4	0.0 to 0.5	Soft, green, gray, clayey SILT
	0.5 to 2.9	Medium stiff, black SILT with Sand interbedding

Table 4 - Summary of Grain Size Characterization Results

Sample Identification	Gravel in percent	Sand in percent	Silt in percent	Clay in percent	Moisture in percent	Material Description
C1	0	36	53	11	41	Slightly clayey, very sandy SILT
C2 (A)	0	29	56	15	44	Clayey, very sandy SILT
C2 (B) Duplicate	0	29	58	13	44	Clayey, very sandy SILT
C2 (C) Triplicate	0	29	58	13	44	Clayey, very sandy SILT
C3	0	21	61	18		Clayey, sandy SILT
C4	0	72	22	6	32	Slightly clayey, silty SAND
C5	1	70	24	5	28	Slightly clayey, silty SAND
C6	0	50	38	12	37	Slightly clayey, very silty SAND

4902/BerthingAreas.xls - table 4

Table 5 - Analytical Results for Sediment Samples
Hurlen Construction Site

Sample-ID Sample Date	PSDDA SL 1998	PSDDA ML 1998	C1 8/27/98	C2 8/27/98	C3 8/27/98	C4 8/27/98
LPAHs in µg/kg						
2-Methylnaphthalene	670	1900	15	130	20	10 U
Acenaphthene	500	2000	49	200	2300	49
Acenaphthylene	560	1300	33	75	89	14
Anthracene	960	13000	200	480	620	150
Fluorene	540	3600	74	240	1100	48
Naphthalene	2100	2400	19	240	22	10 U
Phenanthrene	1500	21000	310	1800	5900	340
Total LPAHs	5200	29000	700	3165	10051	601
HPAHs in µg/kg						
Benzo(a)anthracene	1300	5100	1200	2100	3800	470
Benzo(a)pyrene	1600	3600	520	1700	1900	220
Benzo(b)fluoranthene			570	1700	2200	260
Benzo(k)fluoranthene			410	1400	1700	190
Total Benzofluoranthenes	3200	9900	980	3100	3900	450
Benzo(g,h,i)perylene	670	3200	150	370	300	85
Chrysene	1400	21000	1200	2200	3200	400
Dibenz(a,h)anthracene	230	1900	100	150	79	24
Fluoranthene	1700	30000	2600	5200	15000	2700
Indeno(1,2,3-cd)pyrene	600	4400	290	700	640	170
Pyrene	2600	16000	4400	7200	12000	2000
Total HPAHs	12000	69000	11440	22720	40819	6519
Phenols in µg/kg						
2,4-Dimethylphenol			10 U	10 U	10 U	10 U
2-Methylphenol			10 U	12	10 U	10 U
3- and 4-Methylphenol			10 U	37	10 U	10 U
Pentachlorophenol			50 U	50 U	50 U	50 U
Phenol			10 U	18	10 U	10 U
Phthalates in µg/kg						
Bis(2-ethylhexyl)phthalate	8300		170	460	600	230
Butyl benzyl phthalate	970		10 U	10 U	10 U	32
Di-n-butylphthalate			10 U	10 U	39	10 U
Di-n-octyl phthalate	6200		10 U	10 U	10 U	10 U
Diethylphthalate	1200		50 U	50 U	50 U	50 U
Dimethylphthalate	1400		10 U	10 U	10 U	10 U
Semivolatiles in µg/kg						
1,2,4-Trichlorobenzene			10 U	10 U	10 U	10 U
Benzoic Acid			100 U	100 U	100 U	100 U
Benzyl Alcohol	57	870	50 U	50 U	50 U	50 U
Dibenzofuran	540	1700	43	130	710	33
Hexachlorobenzene	22	230	10 U	10 U	10 U	10 U

able 5 - Analytical Results for Sediment Samples
Hurlen Construction Site

Sample-ID Sample Date	PSDDA SL 1998	PSDDA ML 1998	C1 8/27/98	C2 8/27/98	C3 8/27/98	C4 8/27/98
Hexachlorobutadiene	29	290	10 U	10 U	10 U	10 U
Hexachloroethane	1400	14000	10 U	10 U	10 U	10 U
N-Nitrosodiphenylamine	28	130	10 U	10 U	10 U	10 U
TPH in mg/kg						
Diesel			25 U	25 U	25 U	25 U
Gasoline			20 U	20 U	20 U	20 U
Heavy Fuel Oil			100 U	100 U	100 U	100 U
Jet Fuel as JP-4			20 U	20 U	20 U	20 U
Jet Fuel as Jet A			25 U	25 U	25 U	25 U
Kerosene			25 U	25 U	25 U	25 U
Lube Oil			100 U	100 U	100 U	100 U
Mineral Spirits			25 U	25 U	25 U	25 U
Non-PHC as Diesel			100 U	100 U	100 U	100 U
PHC as Diesel			159	204	318	100 U

Exceeds PSDDA SL.

Exceeds PSDDA ML.

Italicized values represent detection limits greater than PSDDA SL.

U = Not detected.

J = Estimated value.

Table 6 - Analytical Results for Sediment Samples
Boyer Alaska Barge Lines Site

Sample-ID Sample Date	PSDDA SL 1998	PSDDA ML 1998	C5 8/27/98	C6 8/27/98
Conventionals				
Ammonia as Nitrogen in mg/kg			13.1	12.9
Total Sulfide in mg/kg			715	1500
Total Organic Carbon in %			1.04	1.52
Total Volatiles Solids in %			3.34	4.92
Total Solids in %			69.4	65.2
Metals in mg/kg				
Antimony			2.83	3.83
Arsenic	57	700	17	20
Cadmium	5.1	14	0.24	0.48
Chromium			15.2	27
Copper	390	1300	34.4	65.7
Lead	450	1200	33.6	48
Mercury	0.41	2.3	0.08 J	0.18 J
Nickel	140	370	22.9	18.6
Silver	6.1	8.4	0.22	0.42
Zinc	410	3800	84	198
Pore Water TBT in µg/L				
Tri-n-butyltin	0.15		0.05 U	
Pesticide/PCBs in µg/kg				
4,4'-DDD			2 U	3 U
4,4'-DDE			2 U	5 U
4,4'-DDT			2 U	2 U
Total DDT	6.9	69	2 U	5 U
Aldrin	10		2 U	2 U
Chlordane			35 U	35 U
Dieldrin	10		2 U	2 U
Gamma-BHC(Lindane)	10		2 U	2 U
Heptachlor	10		2 U	2 U
Aroclor 1016			10 U	10 U
Aroclor 1221			10 U	10 U
Aroclor 1232			10 U	10 U
Aroclor 1242			10 U	86
Aroclor 1248			10 U	10 U
Aroclor 1254			34	93
Aroclor 1260			20	59
Total PCBs	130	3100	54	238

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Table 6 - Analytical Results for Sediment Samples
Boyer Alaska Barge Lines Site

Sample-ID Sample Date	PSDDA SL 1998	PSDDA ML 1998	C5 8/27/98	C6 8/27/98
LPAHs in µg/kg				
2-Methylnaphthalene	670	1900	10 U	10 U
Acenaphthene	500	2000	33	38
Acenaphthylene	560	1300	10 U	10 U
Anthracene	960	13000	110	140
Fluorene	540	3600	37	52
Naphthalene	2100	2400	10 U	10 U
Phenanthrene	1500	21000	280	410
Total LPAHs	5200	29000	460	640
HPAHs in µg/kg				
Benzo(a)anthracene	1300	5100	410	490
Benzo(a)pyrene	1600	3600	310	430
Benzo(b)fluoranthene			300	10 U
Benzo(k)fluoranthene			230	310
Total Benzofluoranthenes	3200	9900	530	310
Benzo(g,h,i)perylene	670	3200	120	190
Chrysene	1400	21000	400	570
Dibenz(a,h)anthracene	230	1900	32	49
Fluoranthene	1700	30000	1100	1400
Indeno(1,2,3-cd)pyrene	600	4400	240	380
Pyrene	2600	16000	1100	1600
Total HPAHs	12000	69000	4242	5419
Phenols in µg/kg				
2,4-Dimethylphenol			10 U	10 U
2-Methylphenol			10 U	10 U
3- and 4-Methylphenol			10 U	10 U
Pentachlorophenol			50 U	50 U
Phenol			10 U	10 U
Phthalates in µg/kg				
Bis(2-ethylhexyl)phthalate	8300		200	370
Butyl benzyl phthalate	970		10 U	10 U
Di-n-butylphthalate			14	10 U
Di-n-octyl phthalate	6200		10 U	10 U
Diethylphthalate	1200		50 U	50 U
Dimethylphthalate	1400		10 U	10 U
Semivolatiles in µg/kg				
1,2,4-Trichlorobenzene			10 U	10 U
Benzoic Acid			100 U	100 U
Benzyl Alcohol	57	870	50 U	50 U
Dibenzofuran	540	1700	21	24
Hexachlorobenzene	22	230	10 U	10 U

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Table 6 - Analytical Results for Sediment Samples
Boyer Alaska Barge Lines Site

Sample ID Sample Date	PSDDA SL 1998	PSDDA ML 1998	C5 8/27/98	C6 8/27/98
Hexachlorobutadiene	29	290	10 U	10 U
Hexachloroethane	1400	14000	10 U	10 U
N-Nitrosodiphenylamine	28	130	10 U	10 U
TPH in mg/kg				
Diesel			25 U	25 U
Gasoline			20 U	20 U
Heavy Fuel Oil			100 U	100 U
Jet Fuel as JP-4			20 U	20 U
Jet Fuel as Jet A			25 U	25 U
Kerosene			25 U	25 U
Lube Oil			100 U	100 U
Mineral Spirits			25 U	25 U
Non-PHC as Diesel			100 U	100 U
PHC as Diesel			100 U	108

Exceeds PSDDA SL.

Exceeds PSDDA ML.

Italicized values represent detection limits greater than PSDDA SL.

U = Not detected.
J = Estimated value.

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Table 7 - Summary of Biological Toxicity Testing Results- Amphipod Bioassay (*Ampelisca abdita*)

Sample Identification	Test Mean Mortality (M_T) in percent	Control Mean Mortality (M_C) in percent	Reference Mean Mortality (M_R) in percent	M_T-M_C	M_T-M_R	P-Value	Single-Hit Failure	Two-Hit Failure	Overall Result
C1	39	12	12	27	27	0.0801	Pass	Pass	Pass
C4	23	12	23	11	0	0.4769	Pass	Pass	Pass
C5	27	12	23	15	4	0.1946	Pass	Pass	Pass
C6	34	12	12	22	22	0.0158	Pass	Fail	Pass

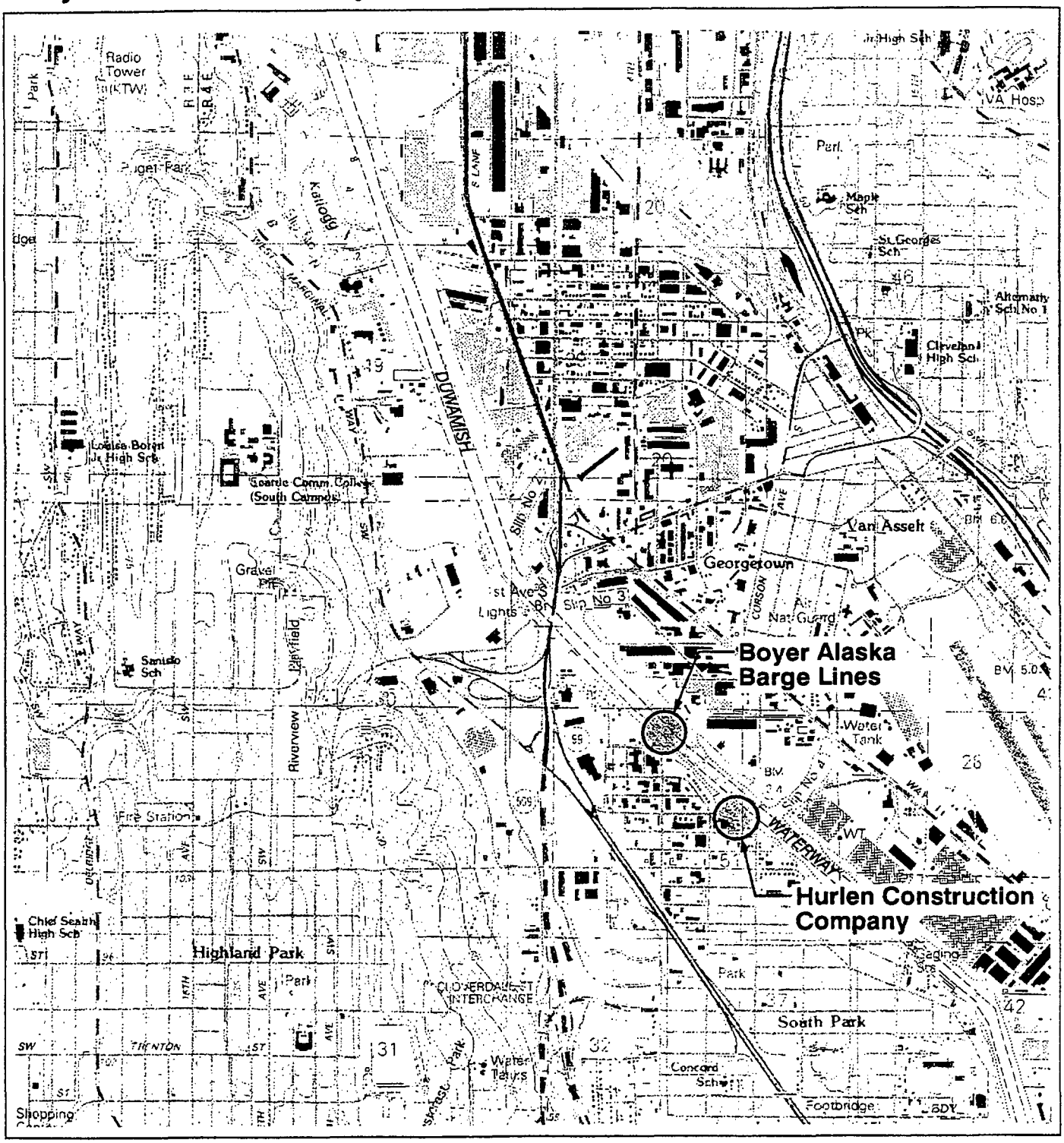
Result does not meet PSDDA non-dispersive disposal site comparative criteria.

Table 8 - Summary of Biological Toxicity Testing Results- Juvenile Infaunal Growth Test (*Neanthes arenaceodentata*)

Sample Identification	Test Individual Growth Rate (G_T)	Control Individual Growth Rate (G_C)	Reference Individual Growth Rate (G_R)	G_T/G_C*100	G_T/G_R*100	P-Value	Single-Hit Failure	Two-Hit Failure	Overall Result
C1	0.48	0.54	0.58	88.9	82.8	0.062	Pass	Pass	Pass
C4	0.48	0.54	0.62	88.9	77.4	0.057	Pass	Pass	Pass
C5	0.40	0.54	0.62	74.1	64.5	0.002	Pass	Fail	Pass
C6	0.47	0.54	0.58	87.0	81.0	0.060	Pass	Pass	Pass

Result does not meet PSDDA non-dispersive disposal site comparative criteria.

Project Location Map



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0 2000 4000

Scale in Feet

Note: Base map prepared from USGS 7.5 minute quadrangle map of Seattle South, Washington.

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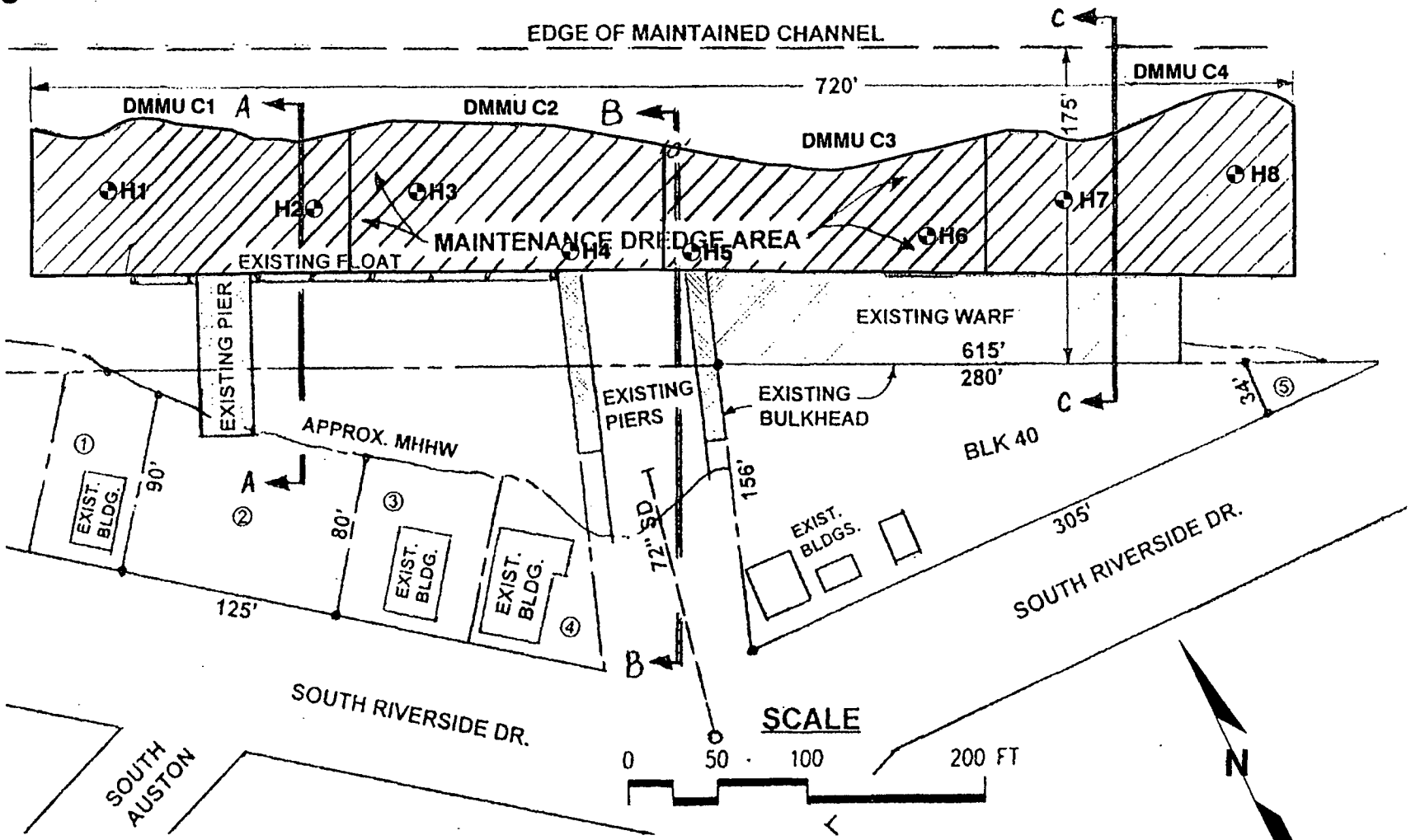
Figure 1

Confirmed Sample Location Plan
Hurlen Dredge Area



H1 Discrete Sediment Sampling Location and Number

Approximate Limit of Dredge Area

Note: Base map based on "Site Plan" Sheet 1 of 2, Hurlen Construction Company, JARPA Application dated 3/30/1998.

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Figure 2

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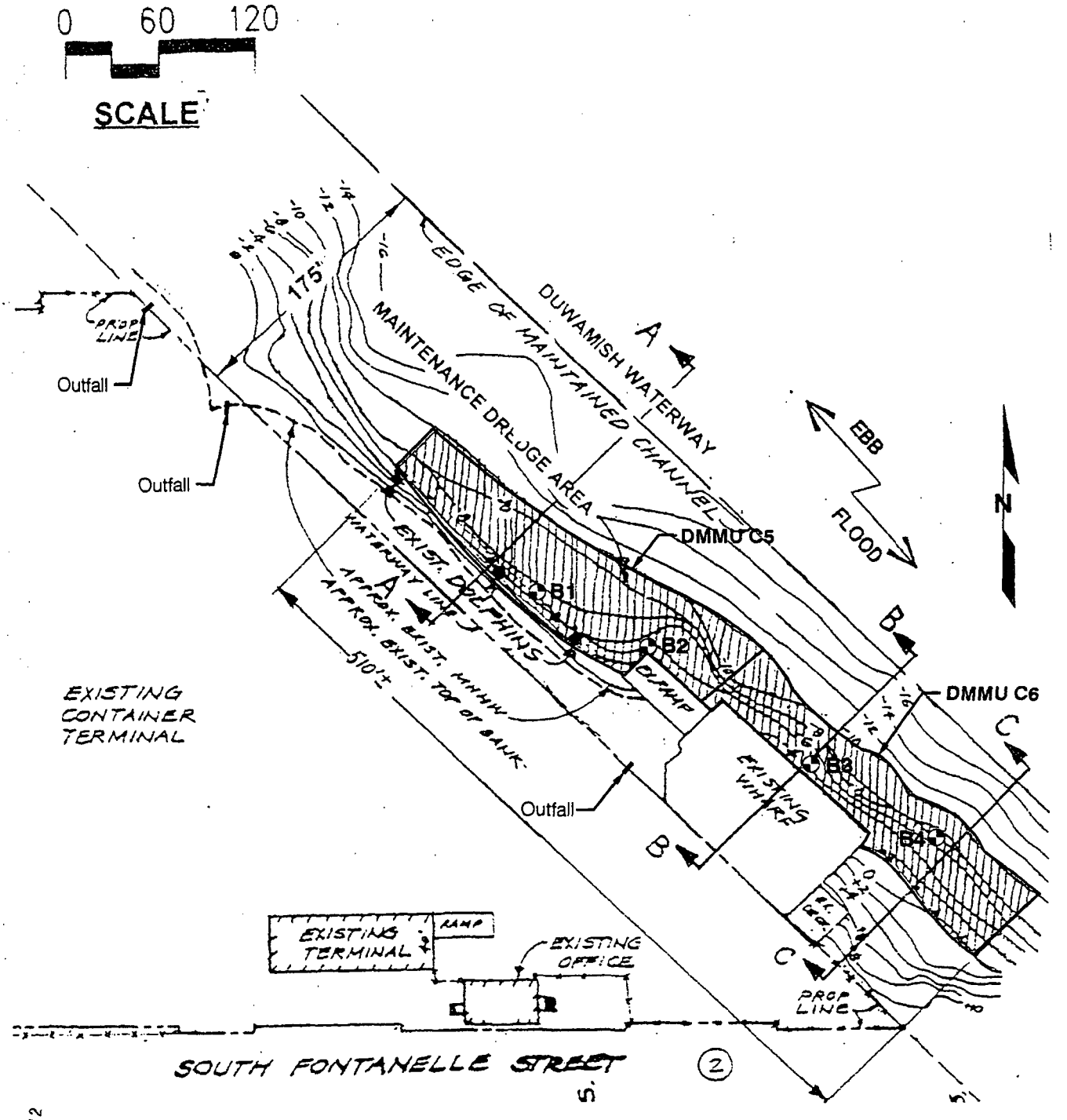
Confirmed Sample Location Plan
Boyer Dredge Area



● **B2** Discrete Sediment Sampling Location and Number

Approximate Limit of Dredge Area.

Note: 1. Base map based on "Site Plan" Sheet 1 of 2, Boyer Alaska Barge Lines JARPA Application dated 3/04/1998.
2. Outfall locations are approximate.

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Figure 3

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